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Special Tooling Disposition for Aircraft

Entering Post Production Support

by

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ABSTRACT

This thesis identifies and analyzes an important element of Department of Defense (DoD) Post Production Support (PPS) for planning and execution: the disposition of special tooling used to support future manufacturing of aircraft components. As a first step, PPS and its goals are described. Next, the DoD policies for special tooling management are described. Finally, the effects of special tooling disposition are analyzed and a decision process for disposition is presented which incorporates these effects. Further research is recommended to measure the effects tooling disposition decisions have on lead times and manufacturing costs when considering conventional, Rapid Acquisition of Manufactured Parts (RAMP) or Flexible Manufacturing System (FMS) manufacturing methods.

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TABLE OF CONTENTS

I.	INTRODUCTION	1
A.	GENERAL	1
B.	OBJECTIVE AND RESEARCH QUESTIONS	2
C.	LITERATURE REVIEW	3
D.	ORGANIZATION OF THE THESIS	4
II.	BACKGROUND	6
A.	INTRODUCTION	6
B.	POST PRODUCTION SUPPORT EMPHASIS	7
C.	ELEMENTS OF PPS PLANNING	8
III.	SPECIAL TOOLING	11
A.	INTRODUCTION	11
B.	MANAGEMENT POLICY (FAR)	11
C.	MANAGEMENT POLICY (AIR FORCE)	14
D.	MANAGEMENT POLICY (NAVY)	16
E.	SUMMARY	19
IV.	SPECIAL TOOLING DISPOSITION	21
A.	INTRODUCTION	21
B.	FUTURE REQUIREMENTS	22
C.	SPECIAL TOOLING INVENTORY	23
D.	DECISION ANALYSIS FOR DISPOSAL AND RETENTION	25
E.	STORAGE AND RETRIEVAL	31
V.	RAMP AND FMS	34

A.	INTRODUCTION	34
B.	RAPID ACQUISITION OF MANUFACTURED PARTS	34
C.	FLEXIBLE MANUFACTURING SYSTEM	36
VI.	SUMMARY, CONCLUSIONS AND RECOMMENDATIONS	39
A.	SUMMARY	39
B.	CONCLUSIONS	40
C.	RECOMMENDATIONS	42
	LIST OF REFERENCES	44
	INITIAL DISTRIBUTION LIST	46

LIST OF FIGURES

Figure 1.	Spares Tooling Decision Process	27
Figure 2.	Judgement Tooling Decision Process	28
Figure 3.	Rate Tooling Decision Process	29
Figure 4.	Assembly Tooling Decision Process	30

I. INTRODUCTION

A. GENERAL

Post Production Support (PPS) is the process of identifying engineering and logistics resource requirements and data necessary to support a weapon system upon termination of its production. Primary emphasis of PPS is to ensure all applicable elements of support are correctly integrated into one support plan. The Department of Defense (DoD) guidelines for PPS are set forth in DoD Directive 5000.39A as follows:

Acquisition and Management of Integrated Logistics Support for Systems and Equipment requires that post production planning be accomplished for all systems and equipment acquisitions. Implementation guidance pertaining to post production support policies is provided in DoD Directive 4000.26, Post Production Support, and in OPNAVINST 5000.49A, Integrated Logistics Support in the Acquisition Process. [Ref. 1]

Additional guidance, found in Task 403 of MIL-STD-1388-1A, is:

Logistics Support Analysis provides requirements for post production support planning and analysis. The goal of the Post Production Support Plan (PPSP) is to ensure continued availability of logistics support following cessation of production by the contractor that is consistent with established readiness and sustainability objectives for the system or equipment. [Ref. 1]

With an increased emphasis for Congress to reduce government expenditures for the acquisition of new weapon systems, the Navy must ensure that it is prepared to support existing aircraft into the twenty-first century. Of the various elements of PPS, this thesis will take an in-depth

look at special tooling, otherwise known as Government Furnished Equipment (GFE) and/or Contractor Furnished Equipment (CFE), and will specifically address disposition of special tooling in support of PPS. Although each type of aircraft will ultimately have its own unique PPS plan, all special tooling disposition should begin with policy and guidance to provide a framework whereby a responsible Assistant Program Manager for Logistics (APML) can steer the special tooling committee toward a feasible disposition plan.

This research effort will examine past and present PPS planning, specifically the special tooling element, to determine the validity of control and disposition once the aircraft is in the post production support phase of its life cycle.

B. OBJECTIVE AND RESEARCH QUESTIONS

The objective of this thesis is to address the problem of special tooling disposition as a critical element of PPS, to describe the control policies and procedures as established by DoD and the Federal Acquisition Regulation (FAR), and to formulate managerial disposition alternatives based on future manufacturing processes and alternate storage plans. Primarily, the research will determine what affects PPS planning decisions for aircraft have on special tooling disposition in DoD.

The following specific questions were developed to achieve the above objective:

1. What is post production support and what are its goals?
2. What are the current DoD policies for special tooling management?
3. Why is special tooling disposition so important and what effects do the disposition decisions have on future support of aircraft entering PPS?
4. What information is important to post production special tooling disposition decisions and how might the decision process be improved?
5. Will technological advancements in future manufacturing systems lead to changes in post production support decisions on tooling disposition?

C. LITERATURE REVIEW

The literature review included the Naval Postgraduate School's (NPS) Thesis Library, the GAO Reports Library, the Federal Acquisition Regulation (FAR), Defense Logistics Studies Information Exchange (DLSIE), computerized data bases, minutes from PPS planning meetings for the EA-6B aircraft, special tooling disposition committee meeting minutes for the EA-6B aircraft, various textbooks covering flexible manufacturing systems (FMS), NAVSUP Guidelines to the Rapid Acquisition and Manufacturing Program (RAMP) and various phone conversations to the Navy Aviation Supply Office, NAVAIR and several aircraft manufacturing plant equipment offices (McDonnell Douglas and Grumman).

D. ORGANIZATION OF THE THESIS

This study provides a comprehensive look at special tooling disposition for aircraft entering PPS. Current and past guidance and policy will be reviewed to determine the effectiveness of sound PPS planning and logical disposition of the special tooling for supporting future manufacturing decisions.

Chapter II, "Background," discusses the role that responsible PPS planning has in supporting aircraft today and in the future. Each element of PPS will be briefly described. Lastly, the nature of the special tooling element will be introduced. It is then discussed in Chapter III.

Chapter III, "Special Tooling," presents and evaluates the special tooling management policies in the Armed Forces; specifically, the Federal Acquisition Regulation and policies of the Air Force and Navy.

Chapter IV, "Special Tooling Disposition," presents the decision variables that affect special tooling disposition planning and execution. Future weapon system requirements will be examined, special tooling inventory accountability and ownership issues analyzed and a decision tree for disposal or retention disposition planning will be presented. Lastly, government and manufacturers' storage for special tooling to provide for rapid retrieval when additional manufacturing is necessary will be discussed.

Chapter V, "RAMP and FMS," analyzes two manufacturing options that have the potential to improve the PPS planning and execution. The effects of these manufacturing processes of the future are considered as ways to simplify the special tooling disposition process. Chapter VI, "Summary, Conclusions and Recommendations," provides a summary of this thesis, presents conclusions from the research and makes recommendations for action and future research.

II. BACKGROUND

A. INTRODUCTION

With the cold war at a close, the threat environment to the United States has changed as has its strategic planning and execution to support a strong military base. Post Production Support (PPS) planning is rapidly becoming the most important logistics support milestone in the life cycle of any weapon platform today. This is expected to be true into the twenty-first century.

A decreased threat environment has created constrained budgetary funding throughout the Department of Defense (DoD). Instead of design, production and deployment of new and improved defense aircraft of the future, the Armed Forces will have to accept budget constraints and plan to support its existing aircraft at minimum cost for an extended period of years. When the production line closes, the aircraft and its supporting repair parts and consumables are no longer manufactured. As a consequence, a plan must be in place to coordinate and integrate future support for the aircraft. The PPS plan serves as the groundwork for the strategy that provides life cycle support of the weapon system. [Ref. 2]

Since PPS represents the systems management and support activities necessary to ensure continued attainment of system

readiness objectives with economical logistics support after cessation of production of the end item, then greater emphasis should be placed on the planning phase of PPS. Through executable planning and proper integration of the PPS planning elements, hardware systems commands and inventory control points can better support the aircraft. [Ref. 3]

B. POST PRODUCTION SUPPORT EMPHASIS

As mentioned earlier, greater emphasis is currently being placed on Post Production Support (PPS) planning than in the past. With the DoD procurement budget shrinking, PPS is taking on a new importance in the phases of life cycle support. Program Managers can no longer rely on manufacturer support throughout the life of the weapon platform. The emphasis today is to transfer the technologies of the manufacturer from development and deployment to the services' field support activities. For example, new acquisitions for naval aircraft programs are not being approved, and support of existing aircraft types (F-14, E-2, and A-6) are being scheduled for transition to Navy field activities. [Ref. 1]

Ideally, PPS planning should be accomplished prior to Milestone II (Full Scale Development) of a system. Identification of design characteristics and industrial base needs necessary to affect cost effective PPS must be developed. Prior to Milestone III (Production and Deployment) plans should be fully developed for cost effective PPS,

including a strategy for continued system and logistics engineering management, requirements identification, acquisition strategies for the future and milestone reviews. All of this is needed to ensure sustained readiness of the system. [Ref. 3]

C. ELEMENTS OF PPS PLANNING

The elements of the PPS plan identify and define all logistics and engineering resource requirements data necessary to support the weapon platform. The goal of the plan is for these elements to support effective integrated logistics and engineering support throughout the system's projected post production life cycle. These elements are: requirements analysis, contracts, program management, sustaining engineering, maintenance policy, technical publications, peculiar support equipment, and special tooling. [Ref. 1]

Requirements analysis addresses the weapon system's primary mission and all its attributes. Also included are the operational requirements and proposed future enhancements to the system. [Ref. 1]

The contracts element identifies existing contracts and basic ordering agreements (BOAs) and determines which should be maintained during post production. In some cases, new BOAs will be initiated to ensure that program requirements are met. Sometimes the manufacturer's expertise will be desired to ensure timely and efficient problem solving during post

production. However, funding requirements for such support is not always available or cost effective. Eventually, all contractor support will diminish as the system transitions to organic support. [Ref. 1]

The program management element describes the duties and responsibilities of the Program Manager and Assistant Program Manager for Logistics. They are responsible for timely and efficient execution of the program in response to OPNAV requirements and funding parameters. [Ref. 1]

The sustaining engineering element is used to support the mission requirements of the system by identifying any engineering problems. Attempts are made to resolve such problems by identifying the substitution of materials, redesigning hardware or software, and redeveloping repair procedures where applicable. [Ref. 1]

The maintenance policy element addresses any changes that might affect maintenance for the system during PPS. Fleet and depot maintenance activity support is reviewed and determined to be adequate or potentially deficient. Any factors that affect the maintenance policy of the system should be addressed. [Ref. 1]

The technical publications element addresses the detailed transition plan for technical manual support from the manufacturer to the cognizant field activity.

The peculiar support equipment element identifies system requirements for performing analysis for all support equipment

end items and to determine primary and alternate sources of logistics support resources after production ends. Requirements for automatic test equipment and intermediate and depot level peculiar support equipment are reviewed and responsibility for control is assigned. [Ref. 1]

All of the PPS elements make up the planning document for post production support execution. However, one element still remains to be described and discussed; the special tooling element which is the basis for future material support of a system in its life cycle beyond full production. This element is the focus of this thesis.

The goals of the special tooling element of PPS are to identify all tooling owned by manufacturers, sub-vendors and the government and to determine the potential for its future use. Such a determination should focus on items expecting to have high future levels of demand and potentially large mobilization requirements rather than on insurance items that lack historical demand and have a high level of usage uncertainty.

In the next chapter the details of the special tooling element will be presented and the management policies for special tooling in the Air Force and Navy will be examined to determine suitability for PPS of aircraft. This management policy will be compared to the Federal Acquisition Regulation for special tooling to determine its usefulness. [Ref. 1]

III. SPECIAL TOOLING

A. INTRODUCTION

Special tooling is defined as jigs, dies, fixtures, molds, patterns, taps, gauges, other unique equipment and manufacturing aids, and components of these items. Special tooling items have such a specialized nature that, without substantial modifications, their use is limited to the production of a specific weapon system and supporting repair parts and consumables. It does not include material, special test equipment, facilities, general or special machine tools or similar capital items. [Ref. 4]

This chapter will describe the management policy for special tooling as described in the Federal Acquisition Regulation (FAR). A comparison analysis of Air Force and Navy management policies will also be made to determine the suitability of each service's special tooling management policy for aircraft during the post production support process.

B. MANAGEMENT POLICY (FAR)

All acquisition regulations governing weapon systems in DoD are contained in the FAR. Aircraft components manufactured prior to 1984 requiring future post production must have their special tooling management programs aligned

with the current requirements in the FAR. In particular, the special tooling management policy is detailed as regulation and guidance for contractors, contracting officers and program managers. First, ownership is based on the type of contract approved. Then, records of the government-owned property are established as the special tooling is introduced into the manufacturing process. Next, the special tooling inventory is entered into a property control system. Physical inventories are taken and recorded for property control. Lastly, as the contract is completed and the system approaches PPS, final inventories are submitted to the responsible agency for disposition. [Ref. 4]

Special tooling ownership is based on the type of contract that is awarded for the system. Under a cost-reimbursement contract, title to special tooling is acquired by the government in all cases. Under a fixed-price contract, the acquisition cost of the special tooling is absorbed in the price of the contract. This makes the property contractor owned and gives the government the option of ultimate title. Any government-owned tooling, provided to support a fixed-price contract, remains government-owned while being accounted for and managed by the contractor. [Ref. 4]

If special tooling is provided by the government or manufactured for a contract, then records of ownership for inventory must be established. The contractor's inventory records will typically provide only the minimum required

information regarding each piece of special tooling. These records are to be made available for government review at any time. Property control records must include: an identifiable contract number for which the tooling was originally acquired, retention codes which will be discussed in Chapter IV, nomenclature or comparable tooling code, tool part number, tool identification number, part number of the item the tooling is used for, unit price, storage code, weight, volume, contractor or subcontractor location and operation sheets showing the process for which the tool is used. The inventory is either kept off-line in hard copy or in a computerized internal contractor tool tracking system. [Ref. 4]

Within 60 days after delivery of the first production system, and 180 days prior to the scheduled last delivery of the system, the contractor shall provide an inventory list of all special tooling to the government. If a storage contract is being considered after last production, then an inventory list shall be provided within 60 days of the storage contract's implementation. In all cases, the inventory lists will be submitted in duplicate to the government's contracting officer, the administrative contracting office and designated inventory control point assigned by the contracting office. [Ref. 4]

Within 180 days of receipt of the inventory list, the contracting officer will provide disposition instructions to the contractor regarding the special tooling inventory. He

can direct the contractor or manufacturer to transfer specified items of special tooling to follow-on contracts, request entrance of the manufacturer into a storage contract at the government's expense, or direct the manufacturer to transfer title of all production special tooling applicable to the government at a suitable government warehousing site. [Ref. 4]

As described, the management policy for special tooling in the FAR is explicit and concise. A brief overview was presented in this section. For a detailed explanation, FAR parts 45 and 52 apply.

C. MANAGEMENT POLICY (AIR FORCE)

The key to effective retention planning in the Air Force is effective coordination between the Air Force Logistics Center (AFLC), the Air Force Systems Command (AFSC), Air Logistics Command (ALC) and the contractor. The goal of the Air Force is to have a post production retention plan in place prior to delivery of the last aircraft. In accordance with Air Force Regulation 78-3, the Air Force has integrated the regulations of the FAR into a special tooling management program. The Air Force, like the FAR, bases its management policy on the type of contract awarded to the manufacturer. [Ref. 5]

For all cost-reimbursement contracts, special tooling retention planning is documented in the PPS plan as outlined

in Air Force Regulation 800-8. Also, Logistics Support Analysis (LSA) provisioning data is used to identify special tooling requirements that supported provisioned spares and consumables. All retention decisions are based on the PPS plan and the LSA process. Normally, special tooling excess in cost-reimbursable contracts is either provided to follow-on contracts or disposed of due to obsolescence. As required, the storage and disposition guidance is followed in accordance with paragraph 22 of AFR 78-3. [Ref. 5]

For all fixed-price contracts, the special tooling is managed by the manufacturer. Like the cost-reimbursement contract, retention planning is documented in the PPS plan and LSA provisioning data is used to identify special tooling required for retention. As inventories are provided to AFLC, data from the LSA will be checked to determine retention or disposal. On occasion, requests are made for the contractor to provide information to support retention planning decisions. [Ref. 5]

Upon receipt of the special tooling inventory, 180 days prior to final production, retention decisions are formulated and plans start to be finalized. Target dates for final disposition instructions and execution of storage contracts coincide with the last delivery date for the end item. Any tooling not identified for retention is disposed of. Storage of special tooling for mobilization requirements or potential future production is either at a contractor or government

facility. Special tooling in storage is screened every twelve months to redefine retention requirements and dispose of unneeded items. [Ref. 5]

D. MANAGEMENT POLICY (NAVY)

Like the Air Force, the Navy special tooling management policy and guidelines for aircraft have integrated and adopted some of the regulations contained in the FAR. NAVAIRINST 4330.8B is being revised (NAVAIRINST 4330.8C draft) in order to adopt the current FAR policy. Since PPS planning is the logistics planning strategy of the future, management and disposition of special tooling for aircraft is being redefined. It is important to note that Navy policy does not detail the differences between special tooling acquired under cost- reimbursement contracts and fixed-price contracts. However, FAR parts 45 and 52 are referenced and expected to be followed. [Ref. 6]

The Program Manager ensures a supporting budget for acquisition and disposition of special tooling including management information necessary to identify, ship and warehouse items for future requirements. He is also responsible for establishing the PPS executive committee which includes a tooling disposition committee. Committee members are qualified representatives from the Naval Air Systems Command, the Navy Aviation Supply Office and applicable Navy Aviation Depots. [Ref. 6]

The Assistant Program Manager for Logistics (APML) is involved in the special tooling identification process. At production phase-out, the APML identifies what is to be transferred to the maintenance facilities and what tooling must be kept for PPS. [Ref. 6]

The Material Reutilization and Disposal Team (AIR-41213) directs the disposal disposition of special tooling no longer required and coordinates with the inventory control point for storage of all required tooling for repairables and consumables produced. [Ref. 6]

The Production Management Division (AIR-114) has a direct liaison with the Procuring Contracting Officer (PCO) for each aircraft and is concerned with the contractor's proposals for special tooling requirements, quantities and costs. AIR-114 reviews all classification codes to ensure that general purpose tooling is not misclassified and handles all disposal and transfer requests. Production Management Division members assist each program manager with disposition and storage planning prior to production phase-out, and justify the funding for special tooling needed for mobilization, initial storage contracts and continued storage in the future. As a whole, AIR-114 is the overseer and manager for special tooling acquisition, use and disposition during an aircraft's life cycle. [Ref. 6]

Lastly, the Procuring Contracting Officer (PCO) provides instructions regarding the use, transfer and disposition of

special tooling to the contractor and the Administrative Contracting Officer (ACO). The ACO is located at the Defense Procurement Regional Office (DPRO), or the Defense Contract Management Area Operation (DECMAO). Most of the applicable instructions are in keeping with the FAR. The PCO also coordinates all special tooling proposals, terminations and plant clearances with the Production Management Division and the Program Manager. [Ref. 6]

The disposition plan followed by NAVAIR includes nine steps. In step one the PCO meets with the prime contractor to obtain any preliminary management special tooling lists. Step two requires the contractor to ensure that each piece of special tooling has a retention code included in the property management record format. After coding is completed, the contractor will sort all special tooling lists by their primary retention code. The inventory lists produced by the contractor will provide all identification and retention information. (Retention codes will be addressed further in Chapter IV.) In step three the contractor will distribute the listings to the PCO who will forward them to the PPS Team. The PPS Team plans tooling disposition execution by matching the retention coded tooling with the naval activity having the primary interest in receiving the tooling. As an example, maintenance tooling is evaluated and considered for disposal or retention by a designated Aviation Depot, and spares tooling is evaluated by the Aviation Supply Office (the Navy's

inventory control point for aviation parts) and NAVAIR-412. Step four is the retention planning phase. The PPS Team screens all inventory listings to determine retention or disposal. Once items are identified for specific disposition, then retention locations are designated to include depots, contractor's and subcontractor's facilities. The PPS Team will also consider any special or routine packing and preservation requirements. Step five commences when the team finalizes its disposition plan and it is forwarded to the PCO who will deliver it to the contractor as a request for proposal. In step six the contractor prepares his proposal to meet the requirements of the disposition plan. This proposal includes packing, shipping and potential storage information and is submitted to the PCO. The PPS Team, in step seven, assists the PCO in analyzing and updating the contractor's proposal. Step eight is the negotiation process between the PCO and the contractor prior to the final awarding of all shipping and storage contracts. Lastly, in step nine, the PCO gives instructions to the contractor for disposition of any remaining special tooling. Normally the contractor will either sell or scrap any remaining tooling. [Ref. 6]

E. SUMMARY

As more attention is focused on accountability of government property and reduced follow-on production of aircraft by the private sector, greater emphasis in PPS

planning and execution of tooling disposition decisions is needed. As a consequence, special tooling management is strongly regulated by the FAR. It contains all regulations regarding acquisition, management and disposition that the manufacturer must follow and the Armed Forces must enforce. Both Air Force and Navy management policies are an adaptation of the FAR policy.

It was not until 1984 that these requirements were included in the FAR. Post production and special tooling management must be enforced by the PCO in accordance with the FAR. In addition, applicable Air Force and Navy policy instructions must be followed by the Program Manager and his special tooling committee.

IV. SPECIAL TOOLING DISPOSITION

A. INTRODUCTION

Special tooling disposition is the process of determining the future mission, requirements and continued life cycle of the post production aircraft. Consideration is given to validating the special tooling inventory on hand at the contractor's facilities, determining which materials to keep and which to eliminate through careful decision analysis, executing a disposal/retention plan and implementing a storage and retrieval system for materials which are retained. Ideally, if the nine steps to disposition planning are followed in accordance with NAVAIR Instruction 4330.8C (draft), then an executable disposition plan which will support the aircraft is possible.

Every disposition plan is unique to the aircraft it supports because the configuration, supportability, sustainability, maintainability, operational availability and mission readiness requirements vary from aircraft to aircraft. The three organizations that are the most concerned with special tooling disposition decisions are the primary contractor, NAVAIR and ASO. The primary contractor requests reduction of government owned out-of-production special tooling in order to provide space for current and future

production contracts. NAVAIR's goal is to plan and execute a disposition plan so that the contract with the primary contractor can be liquidated in a timely manner. ASO is greatly concerned with future inventory requirements determination. Therefore, typically the special tooling disposition committee consists of members from the contractor, NAVAIR, ASO and the cognizant Navy Depot. [Ref. 2]

B. FUTURE REQUIREMENTS

Special tooling decisions require the determination of future requirements for the aircraft. Issues such as future service length, design and configuration changes made in the past, developments for the future, mission requirements, mobilization support, aircraft strength in numbers and intra-service support requirements must be considered prior to planning and executing any special tooling disposition.

As an example, the EA-6B aircraft is projected to remain operational through the year 2010. The EA-6B was designed to provide active jamming, guidance navigation support and on-the-spot electronic, real-time surveillance. During the development phase, one aircraft was manufactured by Grumman in 1966. Four additional aircraft were built for fiscal year 1968. Full scale production was initiated in 1970 when twenty-three aircraft were manufactured. In 1971 the basic configured EA-6B was introduced to the Navy. As of 1992 the EA-6B has undergone five additional configuration changes.

All of these EA-6B configurations currently deployed must be considered by the tooling disposition committee when making support decisions for the future. [Ref. 1]

The decisions for special tooling disposition must be based on a complete package of requirements information on the weapon system. If the special tooling committee is expected to make retention decisions on thousands or even tens of thousands of tools, then it needs such accurate information. Otherwise, disposition actions could take years to complete and could be based on incomplete data. [Ref. 7]

C. SPECIAL TOOLING INVENTORY

The special tooling inventory is comprised of lists of every special tooling item owned, or to be acquired by the government that is in the possession of the contractor that handled manufacturing and supply support of the aircraft regardless of the last configuration produced. Prior to the special tooling committee's execution of a disposition plan, an accurate, valid inventory of all tooling controlled by the contractor for the aircraft must be made available for review.

An assortment of identification information is maintained by the contractor on each item of special tooling. The minimum requirements, as described in chapter III, are contract number, tooling code, tool part number, tool identification number, part number for which the tool is used, unit price, storage code, weight, volume, location, operation

sheets and retention code. The retention code review is an excellent method of making the disposition decisions. It is an alpha numeric code consisting of a primary and secondary code. The primary alpha code is sequenced A through D and has but one corresponding code per tool. Code A is assigned to spares tooling which is required to support a provisioned spare part or assembly. Code B is "judgement" tooling which identifies tools for parts that are not provisioned spares but, in the judgement of the contractor, will be required late in the life cycle of the system for logistics support. Code C is "rate" tooling which is necessary only during a military surge and mobilization to economically produce the system at an increased rate. Lastly, code D tooling, or assembly tooling, is only required to manufacture the end item; it is not for spare parts production. The secondary numeric code is a sub-class of the primary retention code. One or more of these numeric codes, one through four, are assigned to each item of special tooling. Code one designates repair tooling and includes items which could be used for repair of provisioned parts or assemblies. Code two designates replaceable tooling. This code is primarily assigned to spares or judgement tooling. It is the contractor's decision to actually replace spares or judgement tooling if it can be done effectively and economically. Code three designates maintenance tooling which includes items that are capable of being used for depot level maintenance of the the aircraft or

its components. Lastly, code four designates crash damage tooling. Such tooling is required for either provisioned or non-provisioned parts or assemblies that might be required for crash damage repairs to the aircraft. [Ref. 4]

It is the responsibility of the special tooling committee to develop a systematic approach to the tooling lists received from the contractor. Accurate decisions depend on an accurate inventory. If it is in the best interest of the Navy to acquire all lists of special tooling held by the contractor, then NAVAIR submits a statement of work to the contractor outlining specific tasks. The end goal is usually to obtain a complete inventory which includes the identification, classification and function of all government-owned special tooling held at the contractor's and subcontractor's facilities.

D. DECISION ANALYSIS FOR DISPOSAL AND RETENTION

Once the special tooling inventory is complete and contains all the information required to make sound systematic decisions for disposition, then a plan can be executed. There are three primary special tooling disposition decisions: keep everything, dispose of everything, or keep only what might be needed for future support. For an aircraft approaching thirty years of service, keeping everything would mean increased budget requirements to warehouse excess tooling that has become obsolete. Disposing of everything makes supporting the

aircraft in the future difficult, time consuming and costly. A low inventory or a surge in usage rates would create inventory short falls. In addition, long lead times would result for needed items because of the lack of supporting special tooling. The ideal retention decision is to keep only what might be needed in the future. As mentioned above in section C, taking the special tooling inventory and dividing it into the four primary retention codes, spares tooling, judgement tooling, rate tooling and assembly tooling, can facilitate decisions which need to be made for retention and disposal. Figures 1 through 4 are proposed to further facilitate the decision process.

Spares tooling is the first category. Its decision process is outlined in Figure 1. The tooling should be broken down into unique or common special tooling groups. Common tooling would be available through manufacturers that continue to support similar aircraft. Since access to this tooling would be available through an alternate source, the excess inventory can be disposed of. Unique tooling has a manufacturing purpose that is limited to a particular aircraft configuration. Unique special tooling can be further divided into tooling used to manufacture future requirements that are in short supply and tooling used to manufacture future requirements that are in long supply. Depending on the remaining life cycle support required for the aircraft, the latter type of tooling may not need to be retained. However,

if the expected remaining life cycle demand of the items in long supply exceeds the quantities on hand, then retention outweighs disposal as the best option. If the decision is made to retain the tooling, then consideration can be given to the possibility of selling off the current excess inventory of the items held in long supply. This would alleviate some storage expenses. Otherwise, disposal of the tooling is appropriate if usage is expected to meet the life cycle demand. Future requirements for items in short supply may make it necessary to keep spares tooling for these requirements. This category is then further divided into

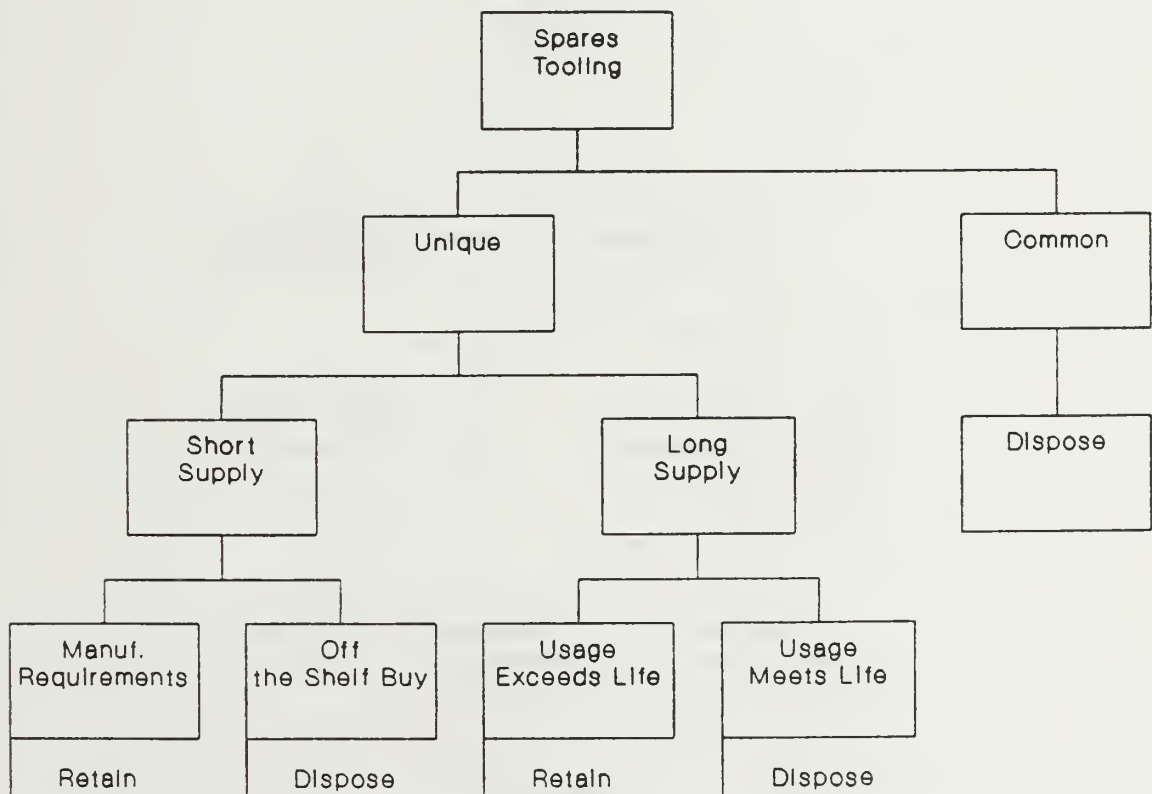


Figure 1. Spares Tooling Decision Process

manufacturing requirements or an off-the-shelf buy. An off-the-shelf buy for all future requirements creates a disposal decision for the spares tooling. The demands for near-term future requirements may create the need for spares tooling retention since manufacturing may need to begin again at the original source if other manufacturers do not exist.

The judgement tooling decision process is outlined in Figure 2. Since judgement tooling is primarily fabrication tooling, it would support a manufacturing requirement that might arise late in the life cycle of the aircraft. Retention of judgement tooling should be based primarily on the aircraft

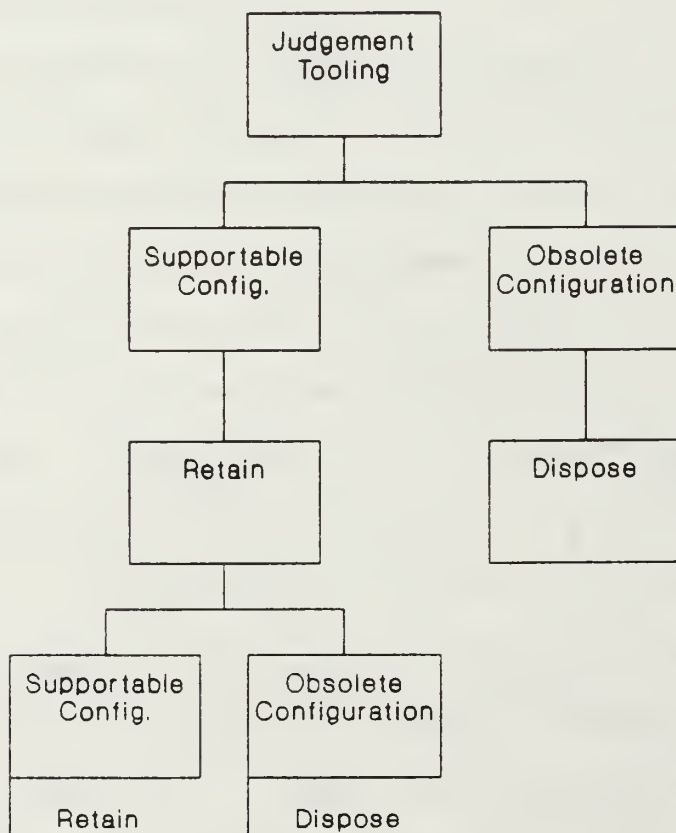


Figure 2. Judgement Tooling Decision Process

configuration being supported. Phased-out or obsolete configurations are of no interest and provide justification for disposal of judgement special tooling. All other judgement tooling should be retained for future life cycle support. However, as the aircraft goes through configuration changes in the future, disposal of tooling which becomes obsolete is then appropriate.

The decision process for rate tooling is outlined in Figure 3. The first phase of the decision process for this group is to determine the actual usage rate for the material during the most recent surge or mobilization. Assuming that

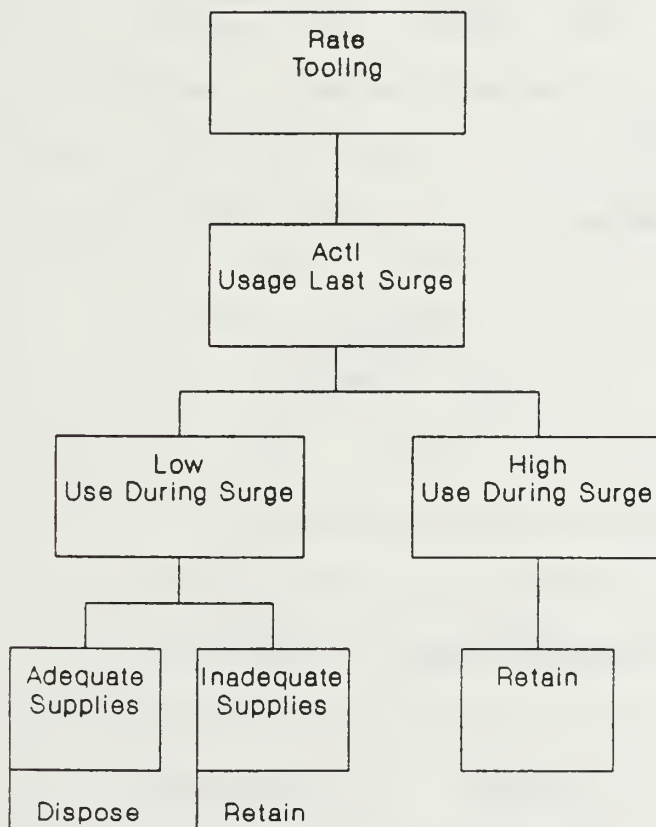


Figure 3. Rate Tooling Decision Process

future surge and mobilization demands will be similiar to those in the past, a low-usage category would result in disposal of the tooling if adequate supplies exist. However, if inadequate supplies exist then all tooling would be considered for retention. A high-usage category would result in a decision favoring retention.

The decision process for assembly tooling is outlined in Figure 4. Since it is only required to manufacture the end item and not for spares production, then this special tooling category is only considered when the need arises to manufacture replacement airframes or large components of the aircraft. In most cases, the assembly tooling will be disposed of due to being obsolete. Assembly tooling should only be retained if the manufacturer's assembly line is predicted to restart in the predictable future.

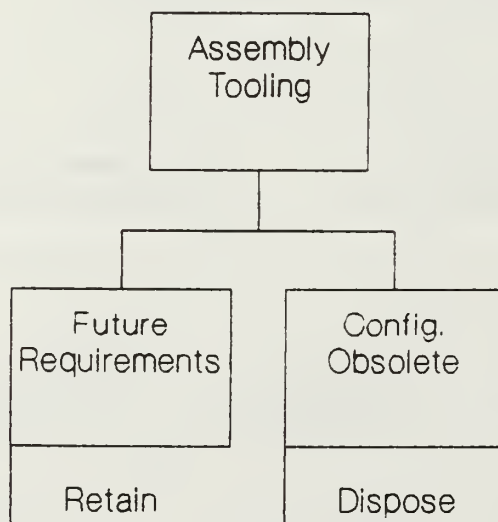


Figure 4. Assembly Tooling Decision Process

Figures 1 through 4 and the associated discussions, though basic in concept, can lead special tooling committees toward an executable disposition plan. The disposition committee has to develop an executable plan and follow through which includes not only these concepts but also the economy, strategic policy, mission of the weapon system, the defense budget and many other constraints to special tooling retention and disposal.

E. STORAGE AND RETRIEVAL

As the special tooling committee finalizes its decisions for disposal or retention, it must next decide where the special tooling will be stored and how will it be tracked and accounted for in anticipation of future usage. For storage needs, three alternatives can be considered. First, the primary contractor provides storage according to the original manufacturing contracts. Second, an alternate contractor provides storage for follow-on contracts requiring ready access to special tooling. Third, the government provides storage facilities for special tooling necessary for future manufacturing by a contractor at a depot maintenance facility or an air station. Contractors are more interested in transferring government property back to DoD than in entering into long term storage contracts. Contractor or manufacturer provided storage, after the production contracts expire, is available on a limited basis and is costly to the government.

As an example, Grumman quoted the Navy a price of thirteen million dollars for all A6E aircraft special tooling to be properly stored. As expected, the APML had no funds for such inflated storage costs.

With the increased number of aircraft entering PPS, a tracking and retrieval system must also be in place for the timely search and retrieval of the tooling required for manufacturing.

The majority of the Air Force's PPS special tooling is stored at contractors' facilities. To track this tooling and that which is stored by the government, the Air Force has developed and implemented a special management information system. This special tooling management system is a part of the Requirements Data Bank (RDB) project which is sponsored by HQ Air Force Logistics Command (AFLC). The system consists of a set of programs designed to track location, utilization and storage of individual pieces of special tooling used throughout AFLC that are required to support an aircraft. The system has the ability to receive, update and maintain files on special tooling inventory. It has an on-line capability that allows the user to view, file, maintain and generate reports of applicable special tooling data. Inputs to the system are made in batch, interactively on-line and via electronic transmissions. Inputs are processed at HQ AFLC as they are received from special tooling contractors. In addition, weekly and quarterly batch processing, with branch

RDB systems at the various Air Logistics Centers, is required to ensure the completeness of the tooling data. [Ref. 8]

The Navy, unlike the Air Force, does not have a special tooling data base for retrieval and tracking. However, the Aviation Supply Office is in the process of implementing a system similar to RDB for special tooling. ASO hopes to build upon the Air Forces' experience gained during the initial learning curve of the RDB implementation. A site visit by representatives from ASO was made to San Antonio Air Logistics Center at Kelley AFB for the purpose of studying their system which uses a mainframe computer. However, ASO representatives prefer the use of a mini-computer to that of a mainframe. A mini-computer that retains the tracking system for input and output functions can be accessed by the existing item manager terminal work stations. [Ref. 9]

Interestingly, during the site visit it was difficult for the Air Force users at ALC Kelley AFB to gain access to the special tooling tracking system filed in the RDB program maintained at AFLC HQ Wright Patterson. An explanation for the problem was not explored but it was not considered to be a recurring problem in the operation of the system. [Ref. 9]

V. RAMP AND FMS

A. INTRODUCTION

As the technological manufacturing base advances, so does DoD's opportunity to become more efficient, independent and self-sustainable without the constraints of long procurement lead time, reduced quality and excessive manufacturing costs. The wave of the future is for the Navy's weapon support systems, after full scale development, to lean toward in-house manufacturing if the selected parts have enough demand to justify such a process as Rapid Acquisition of Manufactured Parts (RAMP). Another alternative is for the Navy to contract procurement of spares with manufacturers that exhibit high levels of efficiency, reasonable costs and quality products with reduced lead time utilizing Flexible Manufacturing Systems (FMS) for production. Keeping in mind that manufacturing technology is constantly improving, either of these manufacturing alternatives could change the strategies of PPS planning today and in the future.

B. RAPID ACQUISITION OF MANUFACTURED PARTS

Rapid Acquisition of Manufactured Parts (RAMP) is a manufacturing system dependent on computer-aided design (CAD) and computer-aided manufacturing (CAM) technology to manufacture small spare parts and printed wiring assemblies.

As a Navy logistics technology, RAMP, is being executed by the Navy Supply Systems Command for direct application in Naval industrial activities. The RAMP concept, unlike conventional manufacturing techniques, will enable the production of repair parts in a timely manner as a way to reduce lead time and inventory holding costs due to excess inventory. This fundamental change by which parts can be manufactured through RAMP cells, can yield a reduction in a spare-part lead time from an average of 300 days to under 30 days. [Ref. 10]

The conventional method of procurement is for a requirement to be passed to a procurement activity responsible for purchasing the part. On occasion, problems relating to ownership rights to specification data, incomplete data packages owned by the Navy, or lack of special tooling, have meant that the Navy has had to reverse-engineer the part or the special tooling required to manufacture the part. As a result, the procurement costs were high. [Ref. 10]

With RAMP, the key to the process is to convert the material specifications into a common machine-readable format called Product Data Exchange Specifications (PDES). Once the digitized PDES data is established, it can be loaded into a computer file which consists of the manufacturing-process steps. This information is relayed to the particular machines which will manufacture the part. An operator is instructed to load the required tools and raw material into the machines. Once the RAMP cell machine is loaded, the computer will take

control of the manufacturing process and build the part in accordance with the PDES specifications. A laser optic system monitors each manufacturing step and provides feedback to the computer. [Ref. 10]

RAMP is unique because it can manufacture according to immediate demand if the PDES specifications data is readily available. Depending on the age and configuration of the system, RAMP is an alternative to consider for aircraft entering PPS. The initial outlay costs are significant due to the reverse engineering needed for PDES development and increased RAMP cell installations to accommodate inter-service manufacturing. However, the savings expected as a result of reductions in lead time, inventory holding costs, special tooling disposition planning and special tooling storage costs could be considerable.

C. FLEXIBLE MANUFACTURING SYSTEM

The concept of a Flexible Manufacturing System (FMS) is similar to that of RAMP, but is used for production and machining in a batch environment where equipment is dedicated to volume production. Automatic tool changing, in-process inspection, parts washing, automated storage and retrieval systems (AS/RS) and other CAM technologies are included in FMS. Batch production in small quantities is not economically feasible using conventional production facilities because of the high tooling and set-up costs. FMS is best suited for

manufacturing mid-volume production (20 to 20,000 items per year) of family-related parts. [Ref. 11]

Like any other manufacturing technology, FMS has advantages and disadvantages. Its advantages include: increased flexibility to respond rapidly to frequent changes in product design and production requirements; reduced lead times due to rapid response to changes in demand, product design, output rates and equipment scheduling; consistent product quality as a result of reduced human error; increased quality control through in-process gauging and inspection; increased standardization and reduced tool inventories. However, high outlay costs, the extreme difficulty in quantifying the benefits of flexible systems, and technical deficiencies in integrating software with hardware resulting in costly debugging time are examples of barriers to FMS. [Ref. 11]

FMS and RAMP have the potential to become vital manufacturing processes for the follow-on production of spares for aircraft dependent on Post Production Support. These manufacturing technology systems could change the strategies of PPS planning. Relying on conventional manufacturing yields a limited retention decision plan (as discussed in Chapter IV) and is not necessarily the most efficient process in terms of time and costs. As alternate manufacturing/machining processes, RAMP or FMS would prove to be more productive in terms of time restraints. However, reverse engineering is

currently a costly part of both RAMP and FMS. As the technology improves and CALS requirements are met, these systems may become more widespread and the cost factor may become less significant.

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

Chapter II provided an overview of post production support (PPS) planning and its increased importance to weapon system support in DoD due to a shrinking DoD procurement budget. The elements of the PPS plan that are necessary to support the continuing mission of a weapon platform were described.

Chapter III described the special tooling element of PPS planning. Specifically, the Federal Acquisition Regulation and Air Force and Navy management policies for special tooling were described.

Chapter IV presented the decision variables that affect special tooling disposition planning and execution. Methods for identifying a weapon system's special tooling inventory were discussed. A simple decision analysis process was then proposed for retention and disposal of special tooling based on the tooling retention codes. Considerations for storage and retrieval were also presented using the Air Force's Requirements Data Bank (RDB) as an example.

Chapter V described two manufacturing options for weapon systems entering PPS which are receiving considerable interest by DoD. Rapid Acquisition of Manufactured Parts (RAMP) and Flexible Manufacturing System (FMS) were both considered as

possible options to resolve the special tooling disposition question.

B. CONCLUSIONS

What is PPS and what are its goals? PPS and its goals were described in Chapter II. PPS embodies the management of support systems required to sustain a weapon system that is no longer in production. Considerations must be made for cost effective logistics and post production configuration changes to the weapon system. The ultimate goal of PPS is to assemble logistics and engineering resource requirements that will enable the system to meet current and future readiness objectives.

What are the current DoD policies for special tooling management? The Federal Acquisition Regulation (FAR), as discussed in Chapter III, is the governing policy for all services with respect to special tooling management. The FAR outlines requirements for contractors, contracting officers and program managers regarding tooling ownership, inventories and disposition. The Air Force, following guidelines set out in the FAR, has implemented an integrated special tooling management program. The FAR has also strongly influenced the PPS strategies for the Navy, as reflected in NAVAIR's detailed management and disposition plan.

Why is special tooling disposition so important and what effects do the disposition decisions have on future support of

aircraft entering PPS? Special tooling disposition, as noted in Chapter IV, is vital to the life cycle of the PPS aircraft. The successful and timely replacement of components depends on the availability of special tooling for manufacturing. Careful decisions must be made regarding retention and disposal of special tooling items. Retained tooling incurs maintenance and storage costs. However, disposal may result in inadequate manufacturing capabilities resulting in long lead times and high costs as these capabilities are improved.

What information is important to post production special tooling disposition decisions and how might the decision process be improved? Special tooling disposition decisions depend on current inventories of special tooling and accurate projections of future usage of a given aircraft. The potential for configuration changes must also be considered. Retention codes assist the disposition decision makers. To facilitate tooling disposition, a decision system process for making retention and disposal decisions is suggested in Chapter IV.

Will technological advancements in future manufacturing systems lead to changes in post production support decisions on tooling disposition? Due to the complexities of RAMP and FMS outlined in Chapter V, it is not likely that either manufacturing system will be implemented for current use as an optimal alternative to maintaining aircraft in PPS. However, as weapon system designs of future acquisitions become

integrated to FMS and RAMP processes as a consequence of CALS, conventional manufacturing should be replaced, special tooling inventories should become smaller and more manageable and special tooling disposition should become a simple transition milestone in the life cycle of a weapon system.

C. RECOMMENDATIONS

The following are recommendations for the special tooling disposition process.

1. Integrate the Navy's special tooling management program more closely with the Federal Acquisition Regulation (FAR) and the Air Force's special tooling management policy. The FAR is a viable, working policy governing special tooling management and provides some consistency for decision makers. When NAVAIRINST 4330.8C is completed, the Navy's management policies should be amended to reflect the updated regulations.

2. Special tooling disposition decisions should be streamlined. Aircraft entering PPS today need tens of thousands of pieces of special tooling which were developed by the manufacturer. For timely execution, disposition should be based on the four primary retention codes as designated by the special tooling committee. Tooling decision processes, like those developed in Chapter IV, should be considered. The ones in Chapter IV are intended to serve as a starting point towards streamlining the decision process.

3. Using RAMP and FMS manufacturing technologies in place of conventional manufacturing is encouraged. However, their implementation into the disposition decision process should not be automatic until they prove to be more time and cost effective than conventional manufacturing tooling methods.

4. Students doing follow on research to this topic should consider the effects that all special tooling disposition decisions will have on lead times and manufacturing costs using either conventional, RAMP or FMS methods.

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